WHAT IS CLAIMED IS:

1. An apparatus for measuring spatial locations, the apparatus comprising:

a first object at a first location;

a second object at a second location;

a waveguide-based interferometer coupled between the first object and the second object;

wherein

the waveguide-based interferometer comprising a waveguide material, the waveguide material being adapted to carry at least a reference beam and a measurement beam;

the reference beam traverses a first path defined within the waveguide material;

the measurement beam traverses a second path defined within the waveguide material and a third path defined outside of the waveguide material, the third path related to at least one of the first location and the second location.

2. The apparatus of claim 1 further comprising a polarization stripping device located on the waveguide material for eliminating a polarization in the measurement beam or the reference beam.

3. The apparatus of claim 2 wherein the polarization stripping device is a TM mode stripping device for eliminating a TM mode in the measurement beam or the reference beam.

4. The apparatus of claim 1 wherein the first path and the second path equal to each other within an accuracy of 5 μm or less.

5. The apparatus of claim 4 wherein the accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

6. The apparatus of claim 1 wherein the waveguide material comprises silica.

7. The apparatus of claim 6 wherein the waveguide material is placed on a silicon layer.

8. An apparatus for measuring spatial locations, the apparatus comprising:

a first object at a first location;

a second object at a second location;

a waveguide-based interferometer coupled between the first object and the second object;

wherein

the waveguide-based interferometer comprising a waveguide material, the waveguide material being adapted to carry at least a reference beam at a reference frequency and a corresponding reference wavelength and a measurement beam at a measurement frequency and a corresponding measurement wavelength;

the reference frequency is different from the measurement frequency;

the reference beam traverses a first path defined within the waveguide material;

the measurement beam traverses a second path defined within the waveguide material and a third path defined outside of the waveguide material, the third path related to at least one of the first location and the second location.

9. The apparatus of claim 8 wherein the first location or the second location is determined within a measurement accuracy of two millionths of the measurement wavelength.

10. The apparatus of claim 9 wherein the first location or the second location is determined within a measurement accuracy equal to or smaller than one millionth of the measurement wavelength.

11. The apparatus of claim 9 wherein the measurement wavelength ranges from a near ultraviolet wavelength to a far infrared wavelength.

12. The apparatus of claim 10 wherein the waveguide-based interferometer further comprises a top surface less than 25 cm^2.

13. The apparatus of claim 12 wherein the waveguide-based interferometer has a weight less than 20 grams.

14. The apparatus of claim 13 wherein the first path and the second path equal to each other within a matching accuracy of 5 μm.

15. The apparatus of claim 14 wherein the matching accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

16. An apparatus for measuring spatial locations, the apparatus comprising:

a first object at a first location;

a second object at a second location;

a waveguide-based interferometer coupled between the first object and the second object;

wherein

the waveguide-based interferometer comprising a waveguide material, the waveguide material being adapted to carry at least a first reference beam at a first frequency and a corresponding first wavelength, a second reference beam at a second frequency and a corresponding second wavelength, a first measurement beam at the first frequency and the corresponding first wavelength, and a second measurement beam at the second frequency and the corresponding wavelength;

the first frequency is different from the second frequency;

the first reference beam traverses a first reference path defined within the waveguide material;

the second reference beam traverses a second reference path defined within the waveguide material;

the first measurement beam traverses a first measurement path defined within the waveguide material and an external path defined outside of the waveguide material, the external path related to at least one of the first location and the second location;

the second measurement beam traverses a second measurement path defined within the waveguide material;

the first measurement path and the first reference path have a first common end;

the second measurement path and the second reference path have a second common end.

17. The apparatus of claim 16 wherein the first measurement path and the second measurement path have a third common end and the first reference path and the second reference path have a fourth common end.

18. The apparatus of claim 17 wherein the first measurement path and the second measurement path equal to each other within a first accuracy of 5 μm.

19. The apparatus of claim 18 wherein the first accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

20 . The apparatus of claim 17 wherein the first reference path and the second reference path equal to each other within a second accuracy of 5 μm or less.

21. The apparatus of claim 20 wherein the second accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

22. An apparatus for measuring spatial locations, the apparatus comprising:

a first object at a first location;

a second object at a second location;

a waveguide-based interferometer coupled between the first object and the second object;

wherein

the waveguide-based interferometer comprising a waveguide material, the waveguide material being adapted to carry at least a first reference beam at a first frequency and a corresponding first wavelength, a second reference beam at a second frequency and a corresponding second wavelength, a first measurement beam at the first frequency and the corresponding first wavelength, and a second measurement beam at the second frequency and the corresponding wavelength;

the first frequency is different from the second frequency;

the first reference beam traverses a first reference path defined within the waveguide material;

the second reference beam traverses a second reference path defined within the waveguide material;

the first measurement beam traverses a first measurement path defined within the waveguide material and a first external path defined outside of the waveguide material, the first external path related to the first location;

the second measurement beam traverses a second measurement path defined within the waveguide material and a second external path defined outside of the waveguide material, the second external path related to the second location;

the first measurement path and the first reference path have a first common end;

the second measurement path and the second reference path have a second common end.

23. The apparatus of claim 22 wherein the first measurement path and the second reference path have a third common end and the second measurement path and the first reference path have a fourth common end.

24. The apparatus of claim 23 wherein the first measurement path and the second reference path equal to each other within a first accuracy of 5 μm or less.

25. The apparatus of claim 24 wherein the first accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

26. The apparatus of claim 23 wherein the first reference path and the second reference path equal to each other within a second accuracy of 5 μm.

27. The apparatus of claim 26 wherein the second accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

28. The apparatus of claim 22 wherein the waveguide material being adapted to further carry at least a third reference beam and a fourth reference beam, the third reference beam traversing a third reference path defined within the waveguide material, the fourth reference beam traversing a fourth reference path defined within the waveguide material, the third reference path and the fourth reference path have a fifth common end, the third reference path diverges from the second reference path at a first diverging point, and the fourth reference path diverging from the first reference path at a second diverging point.

29 . The apparatus of claim 28 wherein the third reference path, the second reference path and the second measurement path have the second common end.

30 . The apparatus of claim 29 wherein the fourth reference path, the first reference path and the first measurement path have the first common end.

31. The apparatus of claim 30 wherein the third reference path and the fourth reference path equal to each other within a third accuracy of 5 μm or less.

32. The apparatus of claim 31 wherein the third accuracy changes in an amount equal to or less than 50 picometers for a temperature change of 1 °c.

33. An apparatus for measuring spatial locations, the apparatus comprising:

a first object at a first location;

a waveguide-based interferometer coupled to the first object;

wherein

the waveguide-based interferometer comprising a waveguide material, the waveguide material being adapted to carry at least a first beam and a second beam;

the first beam traverses a first path defined within the waveguide material;

the second beam traverses a second path defined within the waveguide material and a third path defined outside of the waveguide material, the third path related to the first location.

34. The apparatus of claim 33 wherein an optical length of the first path and an optical length of the second path equal.

35. The apparatus of claim 33 wherein the first beam has a first frequency and the second beam has a second frequency, the first frequency equal to the second frequency.